
A 3D cutaway diagram of the PHENIX detector, showing the internal components and the central collision region. The diagram is rendered in a semi-transparent style, revealing the complex arrangement of detector elements.

The Physics Potential of the PHENIX VTX and FVTX Detectors

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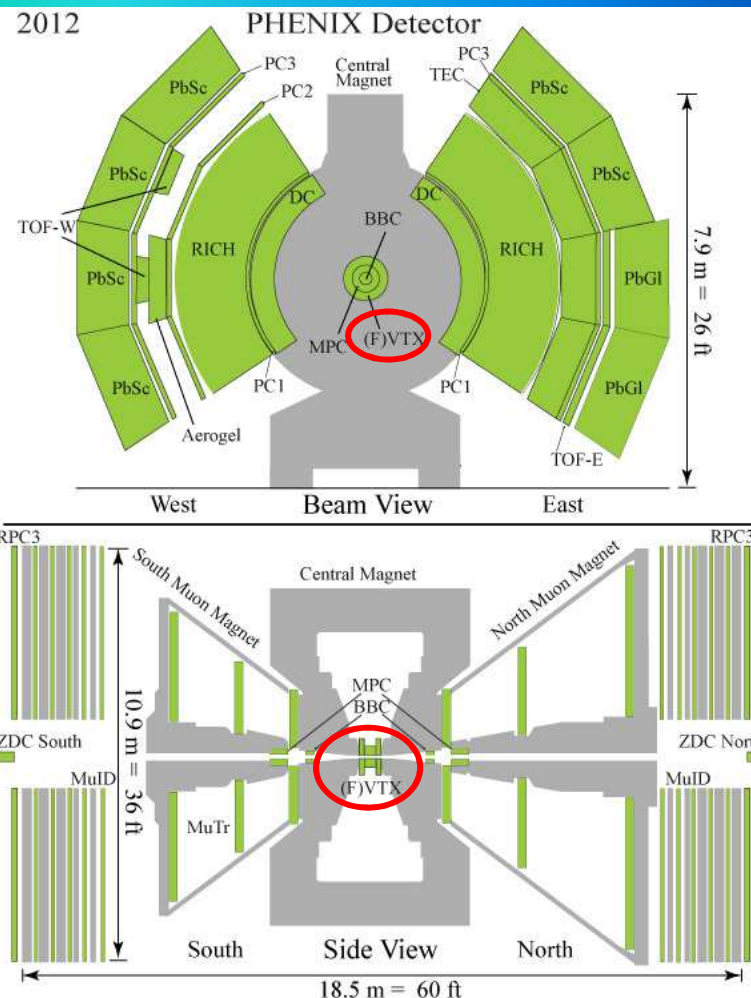
The Relativistic Heavy Ion Collider

- 2 Counter-circulating rings, 3.8 Km circumference
- 200 GeV/Nucleon Au+Au, Cu+Cu, Cu+Au and U+U
- 200/500 GeV polarized p+p
- Search for and study of Quark-Gluon plasma
- Study proton spin



PHENIX In RUN-12

- Hadrons, photons and electrons in central arms
 - Drift and Pad chambers for charged particle tracking.
 - Ring Imaging Cerenkov and electromagnetic calorimeter for electron ID
- Muons and Hadrons in the forward regions
 - Mu ID
 - Mu Trackers
 - RPCs RUN 11/12 Upgrade
- VTX for central tracking
- FVTX for forward tracking



Heavy Flavor Measurement in PHENIX

- Heavy flavor decays measured indirectly in semi-leptonic decays
- Measure the spectrum of all electrons
- Subtract background sources
 - Photonic using cocktail of known sources
 - Conversion photons from light meson decays
 - Direct photons from hard scattering process
 - Dalitz decays, p^0 , h , ...
 - Quarkonia contributions
- Separation of B and C decays not possible

Forward Physics at PHENIX

- Heavy Ion Physics
 - J/Ψ as a probe of QGP
 - Elliptic Flow
 - Reaction plane: R_{AA}
 - Cold Nuclear Effects
- Spin Physics
 - Drell-Yan: Sea quark contribution to proton spin
 - W Program
- Large backgrounds make these measurements difficult

PHENIX Upgrades

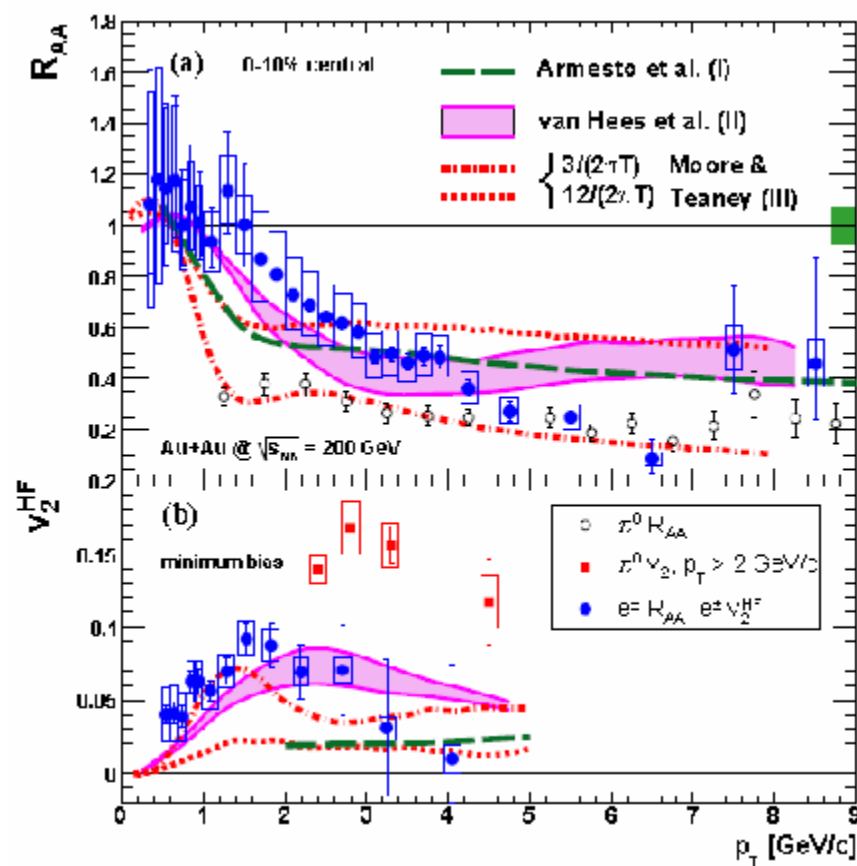
- Recent upgrades to PHENIX tracking
 - Central Silicon Vertex Detector (VTX)
 - Installed in 2010 for RUN-11
 - Forward Silicon Vertex Detector (FVTX)
 - Installed in 2011 for RUN-12
 - Improved vertex resolution
 - Designed to separate heavy decays (charm and bottom)
 - Improved measurements for both Heavy Ion and Spin Physics at PHENIX

Physics of the VTX

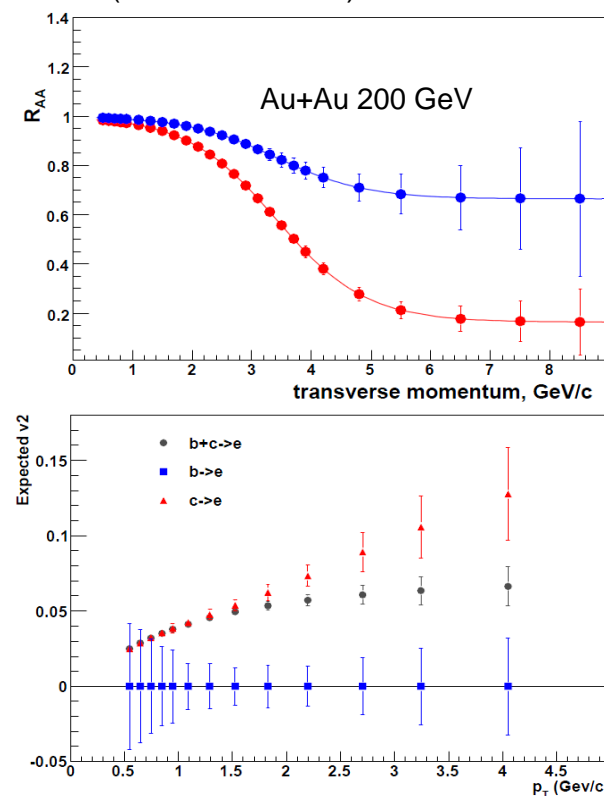
- Heavy Ions:
 - Heavy flavor production along with beauty and charm separation constrain energy loss models
 - Charm measurements along with improved vector meson measurements helps with the understanding of vector meson production and suppression
 - Charm and beauty energy flow
- Spin:
 - Heavy flavor measurements allow understanding of gluon spin contribution.

VTX R_{AA} and V_2 Measurements

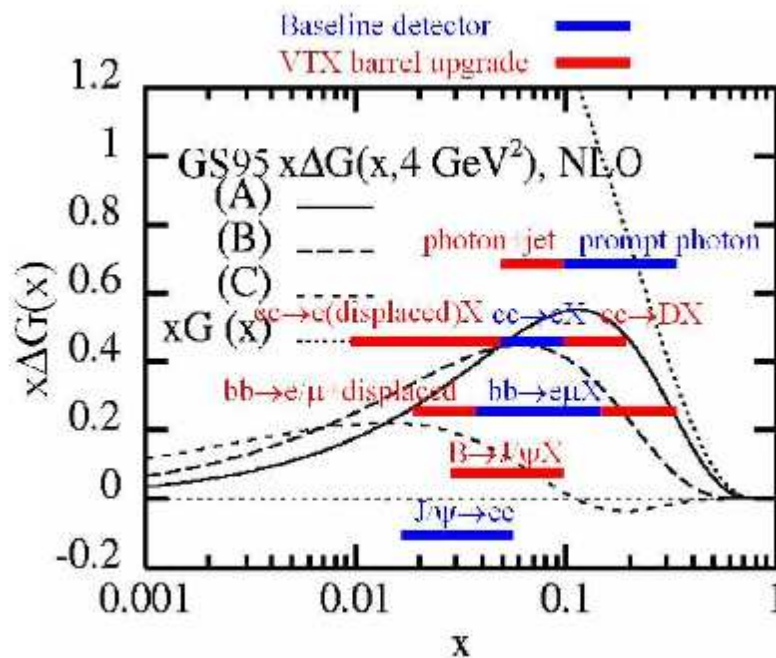
Current: PHENIX PRL 98:172301 (2007)



Expected with VTX
(4.8B MB events)



VTX Gluon Polarization Measurement



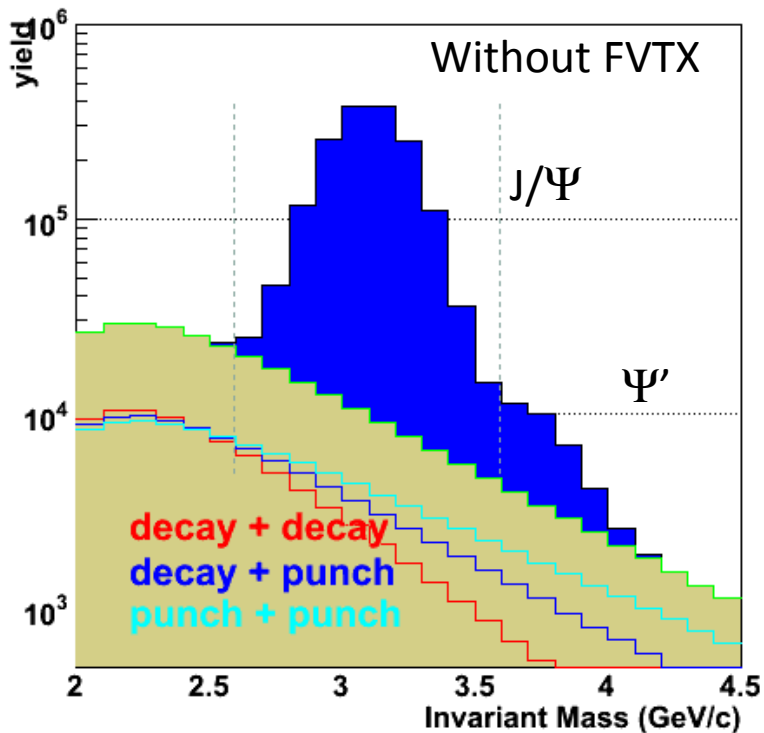
- Gluon-Compton process, Photon+ Jet is a “golden” channel
- Large acceptance of VTX allows reconstruction of x from the recoil jet axis
- Allows extending the x -range over current detector.

FVTX Physics

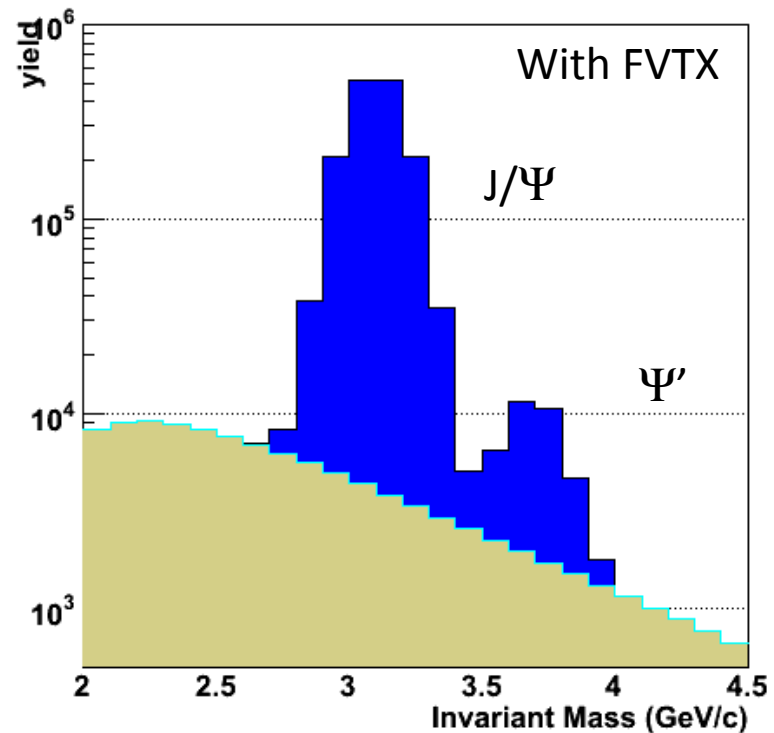
- Single Muons:
 - Precision heavy flavor and hadron measurements at forward rapidity
 - Separation of charm and beauty
 - W background rejection improved
- Dimuons:
 - Direct measurement of bottom via $B \rightarrow J/\psi$
 - Separation of J/ψ from ψ' with improved resolution.
 - Direct measurement of c-cbar events via $\mu^+\mu^-$ becomes possible
- Physics:
 - Precise heavy flavor measurements of R_{AA} and flow.
 - Detection of ψ' plus heavy quark allows detailed understanding of vector meson production and modification
 - Precise gluon polarization and sea quark measurements over large x range,

Expected Improvement in J/Ψ

Dimuon invariant mass distribution

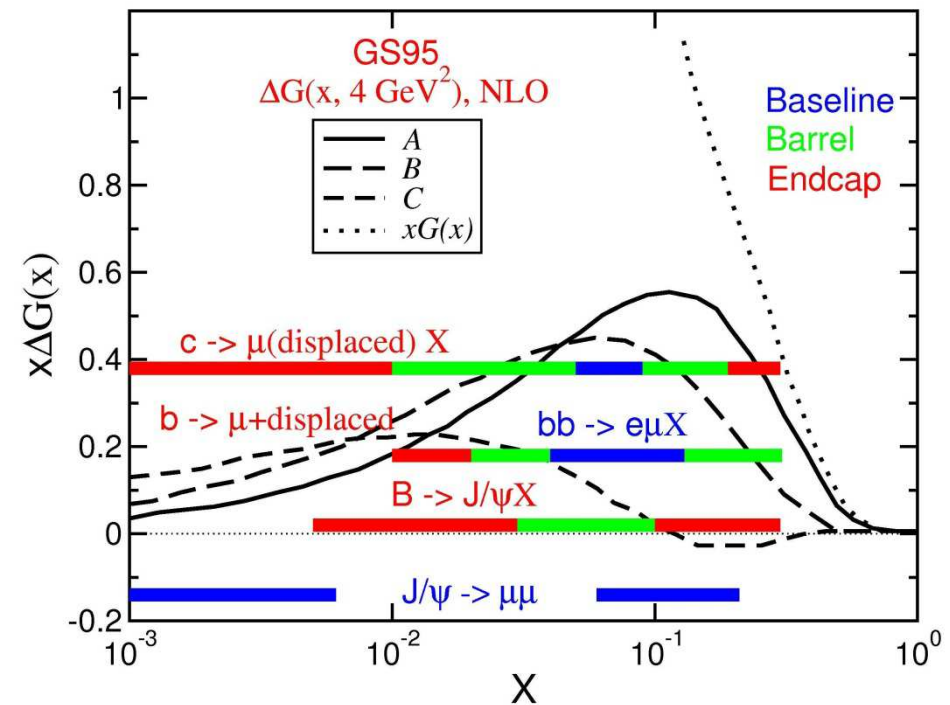


Dimuon invariant mass distribution



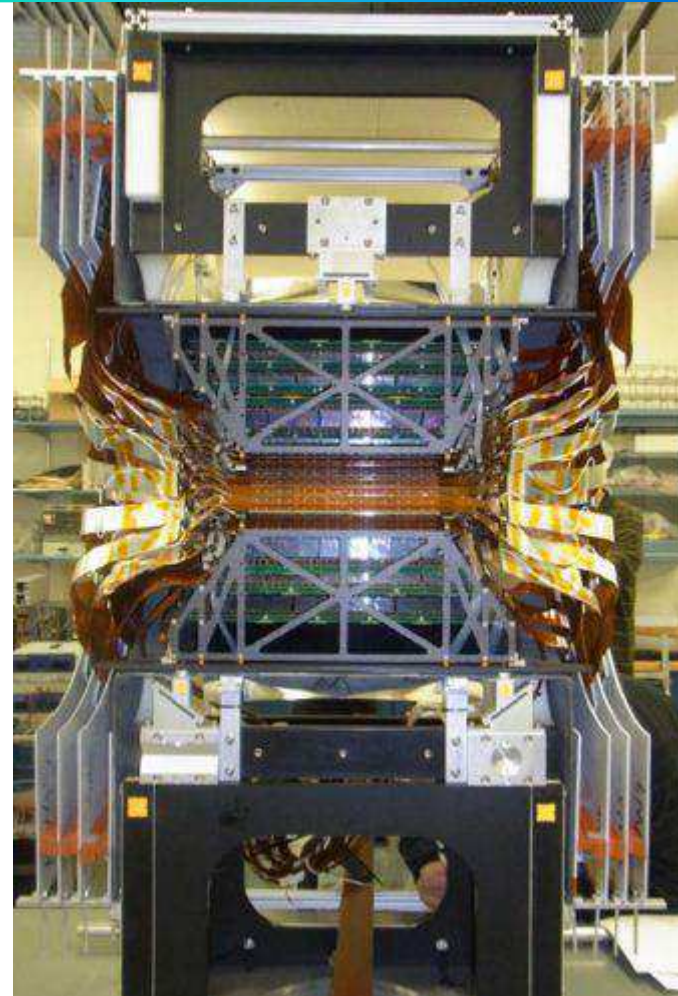
Spin Measurement Improvements

- FVTX allows precision measurements for heavy quarks
- Extends the X range in both directions.
- Curves show various estimates of the gluon polarization (T. Gehrmann and W. J. Stirling, Z. Phys. C65, 461 (1995))



The VTX

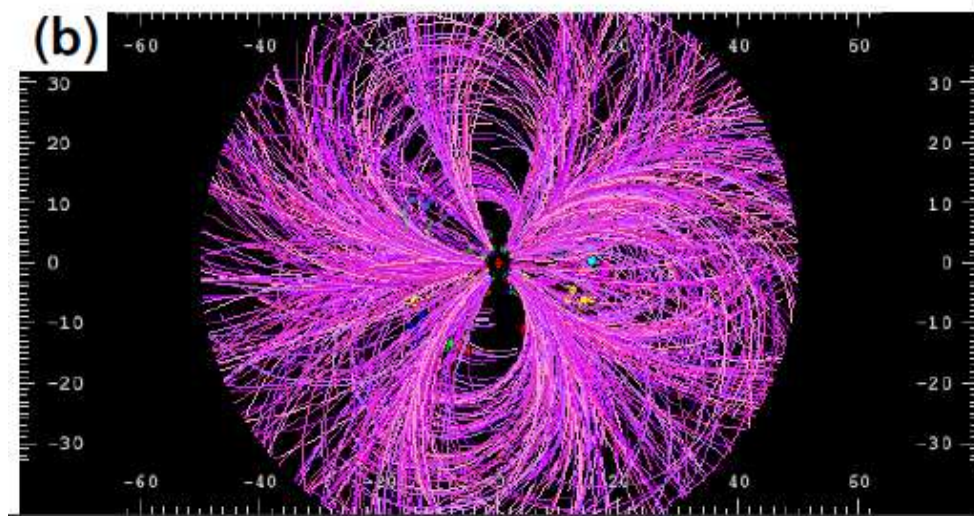
- 4 Barrels
 - Inner 2 barrels, pixels
 - Outer 2 barrels, 2-D Strips
 - Covers $|\eta| < 1.2$
 - DCA resolution of $50\mu\text{m}$
 - Secondary Vertex finding
 - b/c separation
 - $D \rightarrow K\pi$, $B \rightarrow J/\Psi + X$,
 $J/\Psi \rightarrow e^+e^-$



VTX Current Status

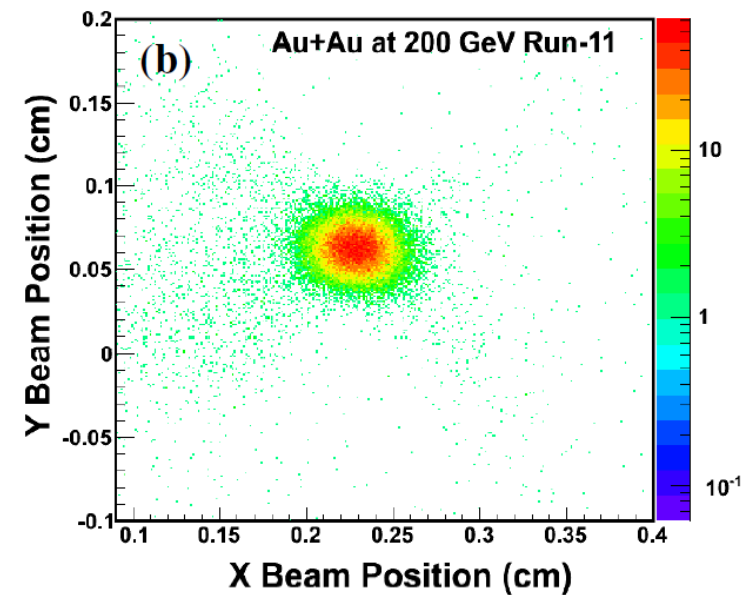
- Installed prior to RUN-11
- Commissioned during 500 GeV p-p running
- 4.8B Minimum Bias 200 GeV Au-Au events recorded with VTX
- Physics analysis in progress
- RUN-12 in progress:
 - 200 GeV and 500 GeV p-p
 - U-U and Cu-Au runs to come

VTX In RUN-11



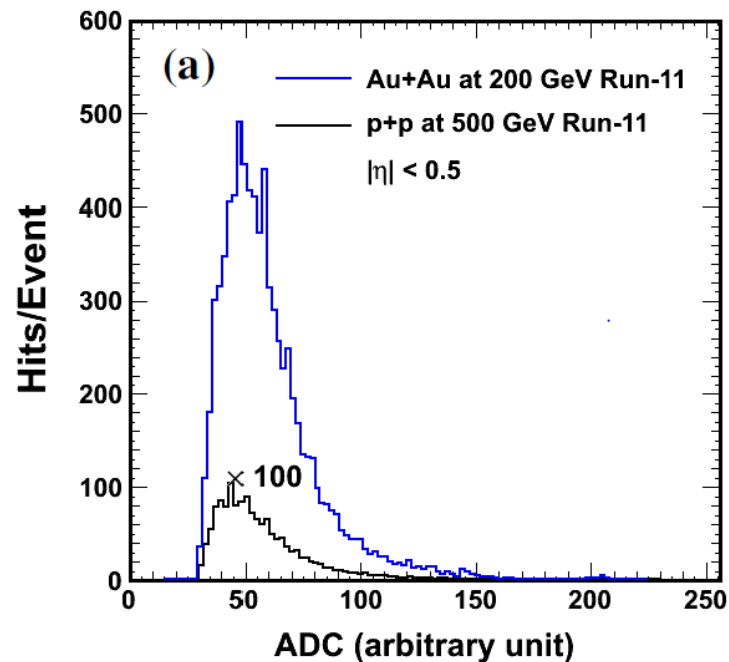
The reconstructed beam spot using VTX tracks
Measured size is $105\mu\text{m}$ and consistent with expected size

Typical 200 GeV Au-Au reconstructed event from RUN-11



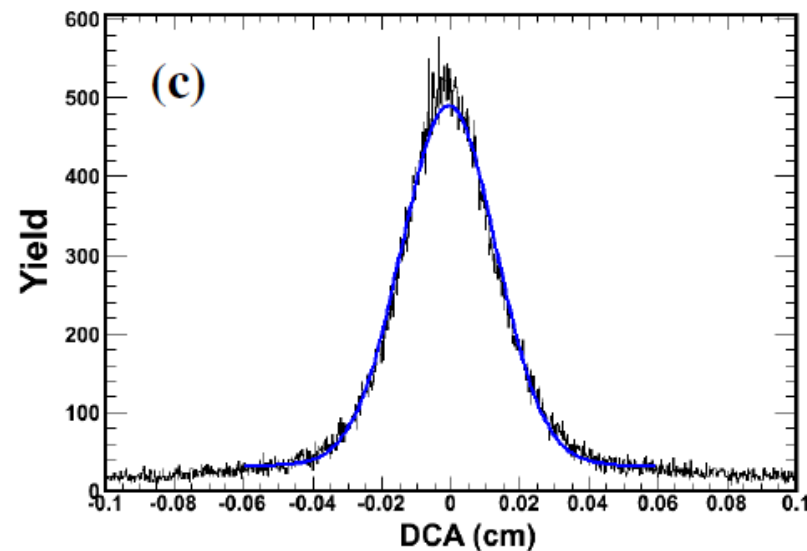
Figures courtesy of R. Nouicer

VTX In Run 11



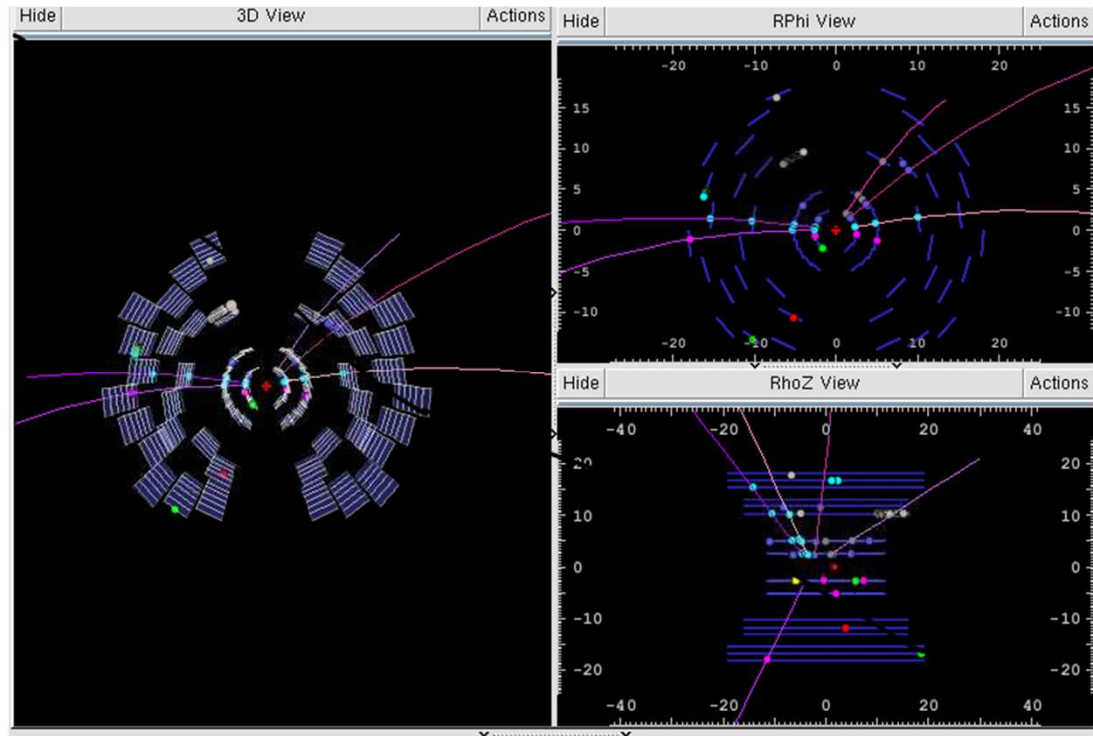
Energy deposition in the strip layers for tracks with $|\eta| < 0.5$

Single track DCA to the beam spot.
Estimated DCA resolution is $88\mu\text{m}$ for tracks with a $p_T > 1\text{GeV}$



Figures courtesy of R. Nouicer

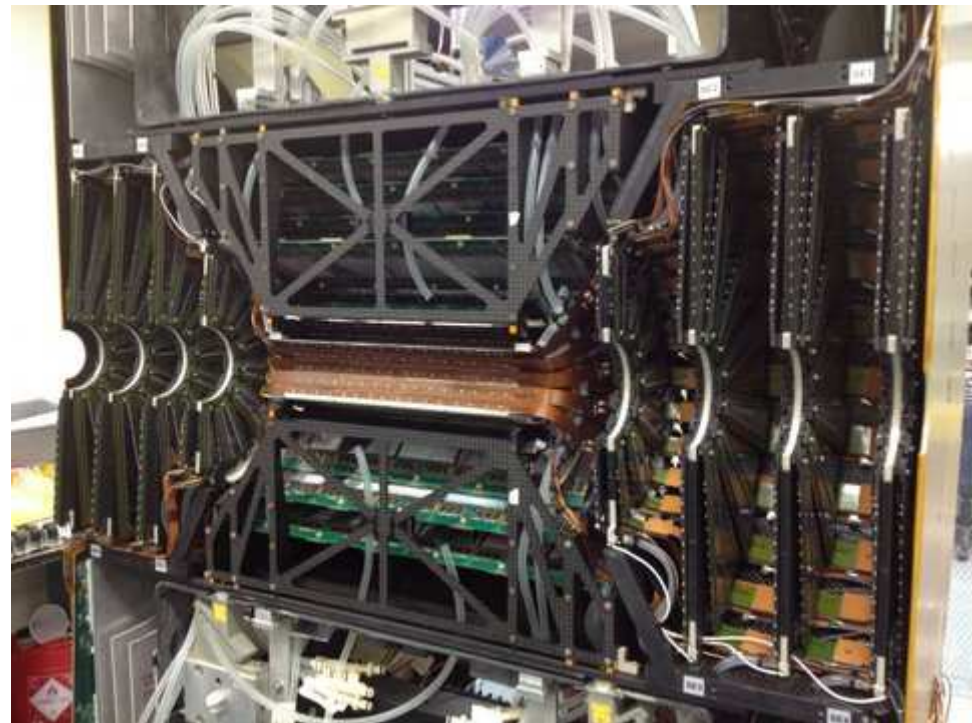
VTX In RUN-12



Reconstructed 200 GeV
p-p event from RUN-12

The FVTX

- 4 planes per end-cap
- Covers
 - $1.2 < |\eta| < 2.4$
 - 2π in ϕ
 - $18.5 \text{ cm} < |z| < 38 \text{ cm}$
- Resolution:
 - Hit $< 25\mu\text{m}$
 - DCA $< 200 \mu\text{m}$



FVTX Status

- Construction completed and detector installed in 2011
- Commissioning during RUN-12 200/500 GeV p+p running
- Data taking has started in RUN-12:
 - 200/500 GeV p+p
 - 200 GeV U+U
 - 200 GeV Cu+Au
- Data analysis is in progress

FVTX Status

- Single track projection to the Z-axis
 - From RUN-12 500 GeV p-p data
 - Comparison with BBC vertex

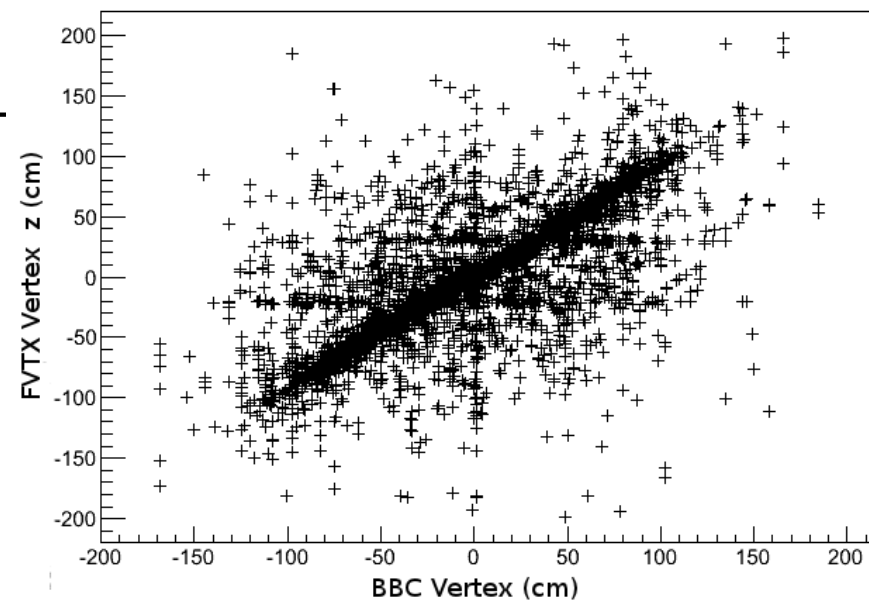


Figure courtesy A. Key

FVTX Tracking

- Preliminary hit resolution
- Analysis is still in a very preliminary state
- Will improve as alignment is finalized

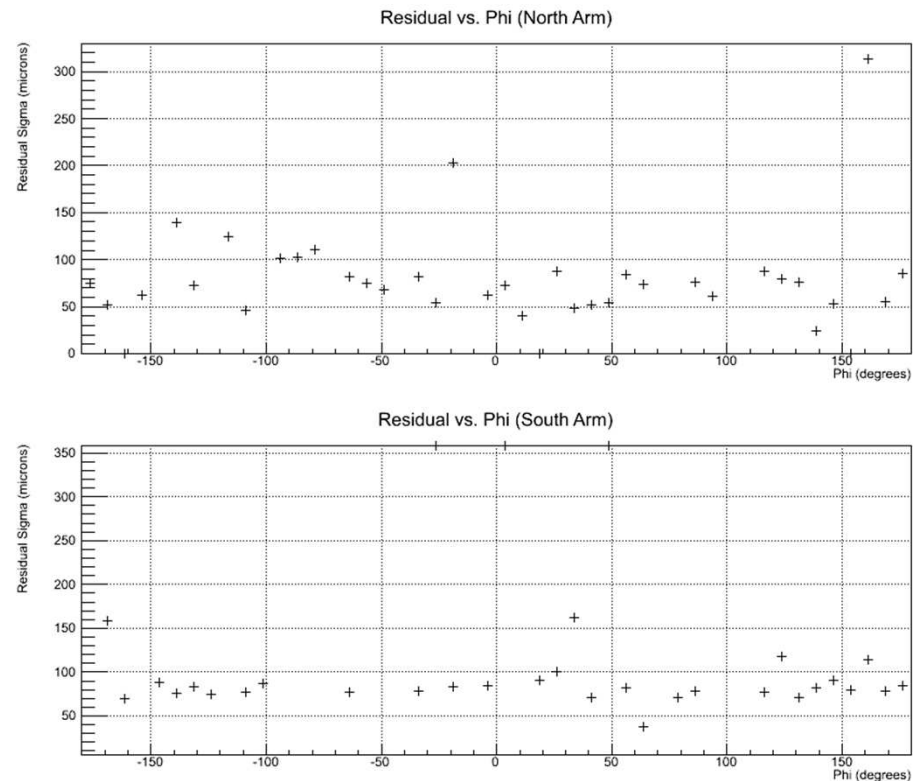


Figure courtesy A. Key

Conclusions

- Both the VTX and FVTX have been successfully installed
- VTX has taken data for RUN-11 and RUN-12:
- FVTX has taken data for RUN-12
- Analysis of VTX/FVTX data is in progress
- Look for first results from VTX at QM-12, FVTX results will follow quickly after that

Special Thanks To

Member of the PHENIX VTX and FVTX groups

The PHENIX technical staff

Members of the PHENIX Collaboration

BNL C-AD Department

The Organizers of WWND 2012